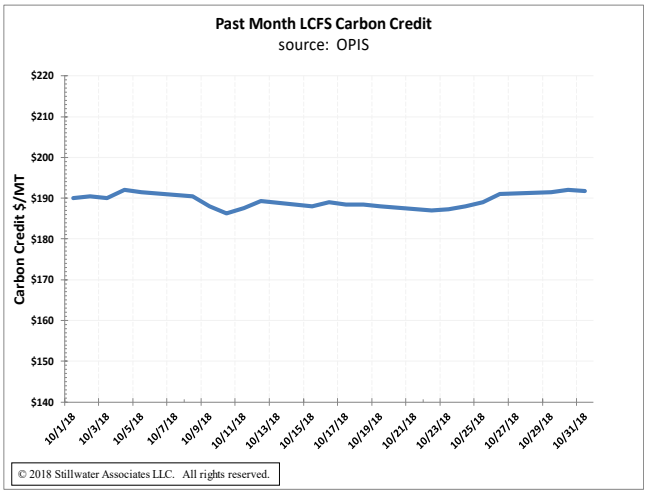
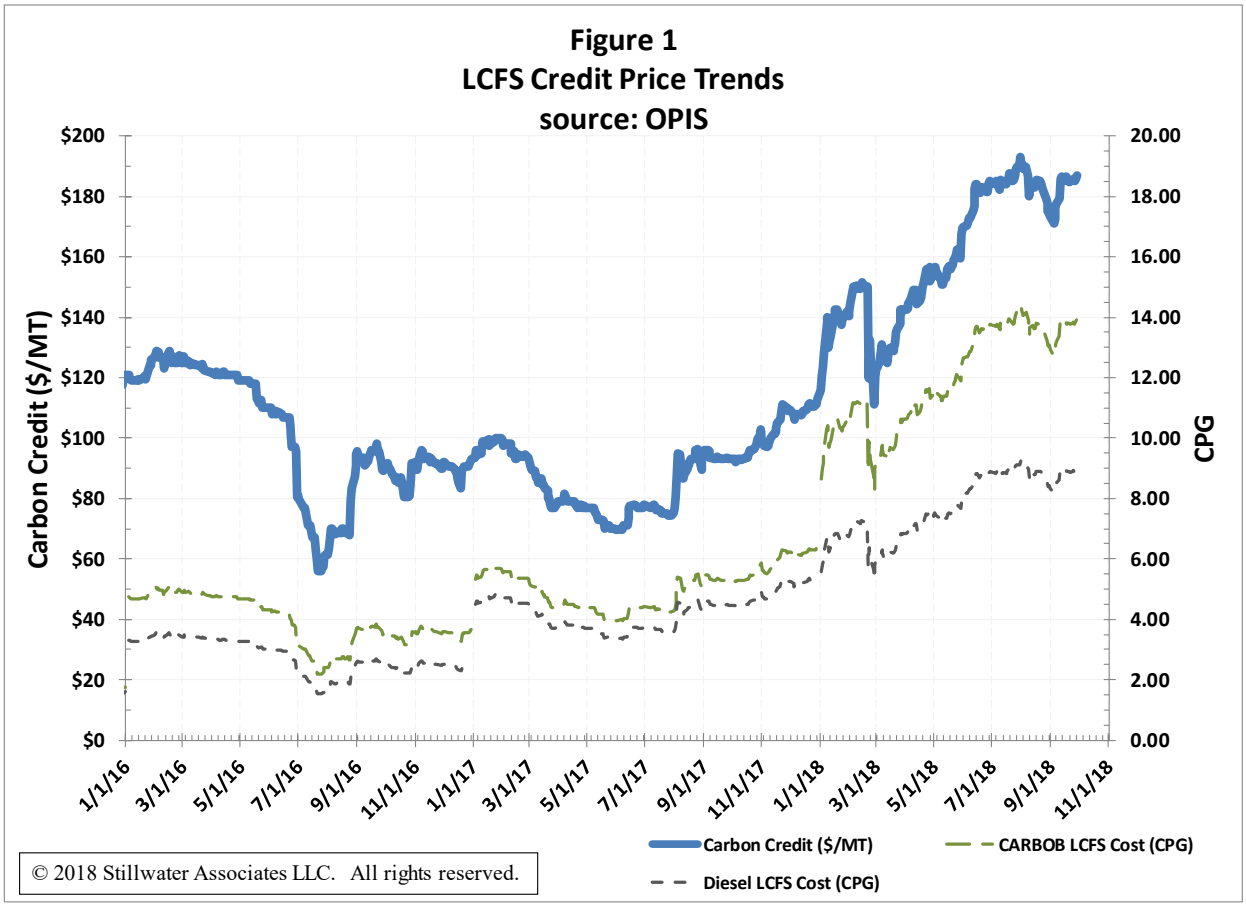
# California Low Carbon Fuel Standard (LCFS)
# Monthly Newsletter
# October 2018

## LCFS Credit Price Trend

For October, LCFS credit prices ranged from $186.25 to $192 per metric ton (MT) of carbon dioxide equivalent ($CO_2e$). The month closed out at $191.75/MT – 2.5% higher than September's closing price of $187/MT. For October, prices averaged $189/MT compared to an average of $95/MT for the same month last year, and an overall average of $89/MT for 2017. For 2018, a credit price of $191.75/MT correlates to 14.3 cents per gallon (CPG) for gasoline and 9.2 CPG for diesel. Since the beginning of 2018, LCFS credit prices have averaged $163.80/MT, with a low of $111/MT and a high of $193/MT – that high being recorded during the last week of July.



## LCFS Credit Trading

Table 1 displays the number, volume, and average price of credits as reported in the California Air Resources Board (CARB) Monthly LCFS Credit Transfer Activity Report for October.

**Table 1**
**LCFS Credit Trading Reported by CARB**

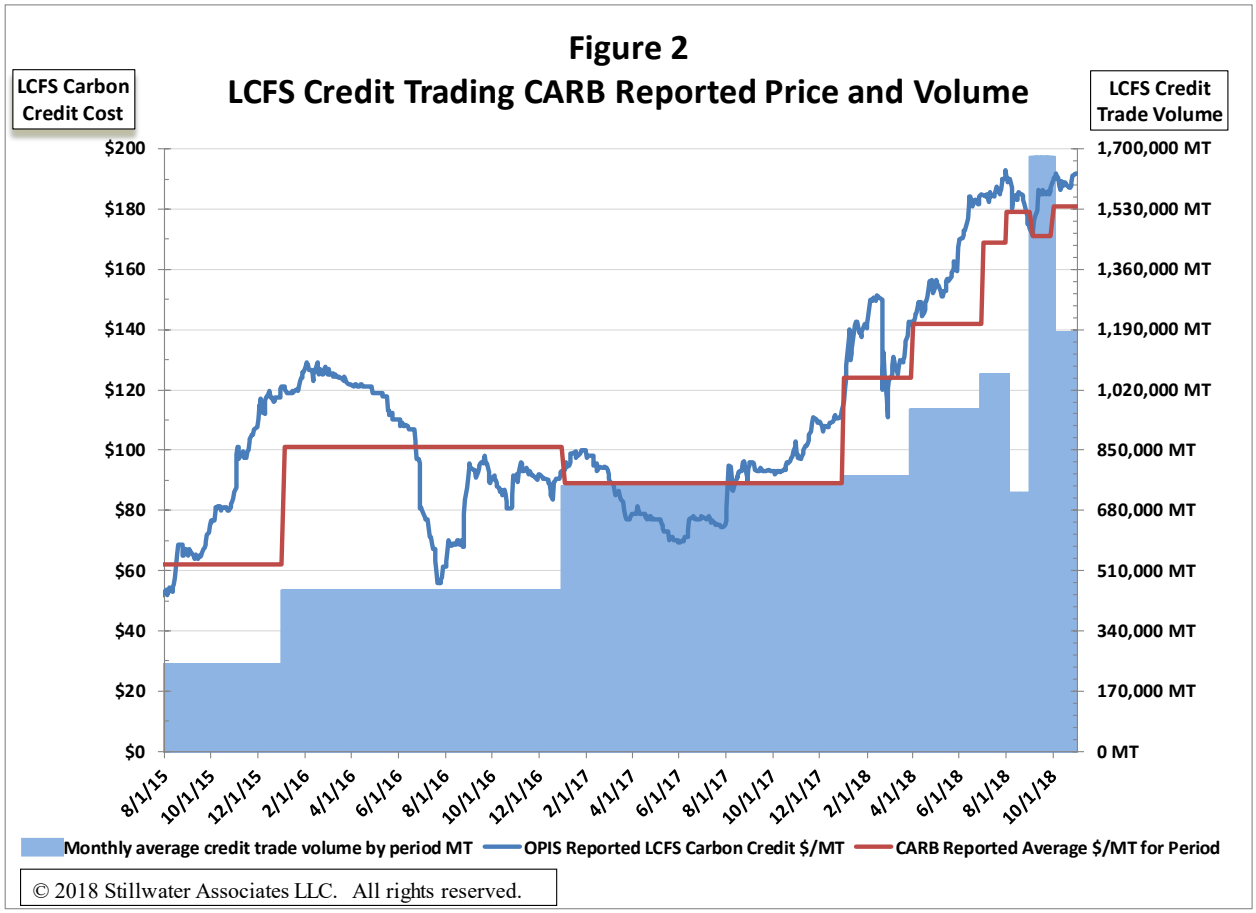
| Time Period | | Total Transfers (number) | Total Volume (credits-MTs) | Avg. Price ($ per Credit) Per ARB Report | Price Range ($ per Credit) | Ave Transaction Size - MT | Transactions per Week |
|---|---|---|---|---|---|---|---|
| CY 2012 | | 24 | 164,000 | $17 | | 6,833 | 0.5 |
| CY 2013 | | 202 | 887,000 | $55 | | 4,391 | 3.9 |
| CY 2014 | | 304 | 1,667,000 | $31 | | 5,484 | 5.8 |
| CY 2015 | | 578 | 2,852,000 | $62 | | 4,934 | 11.1 |
| CY 2016 | | 929 | 5,343,000 | $101 | | 5,751 | 17.8 |
| CY 2017 | | 1226 | 8,875,000 | $89 | | 7,239 | 23.5 |
| Q1 2018 | | 322 | 2,299,000 | $124 | | 7,140 | 25.0 |
| Q2 2018 | | 413 | 2,867,000 | $142 | | 6,942 | 31.8 |
| Jul-18 | | 122 | 1,056,000 | $169 | $100 - $190 | 8,656 | 27.5 |
| Aug-18 | | 117 | 722,000 | $179 | $92 - $193 | 6,171 | 26.4 |
| Sep-18 | | 195 | 1,668,000 | $171 | $108 - $190 | 8,554 | 45.5 |
| Oct-18 | | 164 | 1,172,000 | $181 | $122 - $192 | 7,146 | 37.0 |
| TOTALS | | 4,596 | 29,572,000 | $105 | | 6,434 | 12.9 |

| Number of RPs | Selling | Buying | Both |
|---|---|---|---|
| | 103 | 27 | 85 |

*Source: CARB Monthly LCFS Credit Trading Activity Report for October 2018 and prior reports*

The number of reported transactions decreased by 16% from 195 in September to 164 in October. The volume of credits also decreased by 30% from 1,668,000 in September to 1,172,000 reported in October. CARB's reports include some related party transactions. The October weighted average price reported by CARB was $181/MT which is slightly lower than the $189/MT average calculated by daily price reports.

Figure 2 graphically illustrates the monthly average transaction values and the volume of credits traded, as reported by CARB, and shows the LCFS credit price reported daily by OPIS.



## Monthly Highlight: The LCFS Credit Market: What Could Rock the Boat?

With the dramatic increase in reported LCFS credit prices over the last year, many subscribers to this newsletter ask us what could cause a significant decrease in these prices. While Stillwater Associates does not attempt to forecast market prices specifically, this article aims to build up the fundamentals to provide subscribers with a framework to help inform their evaluations.

The following analysis examines factors which could cause a decrease in the market price of LCFS credits. Four potential scenarios are reviewed to quantify this risk. Absent a legislatively directed program change or an intervention by the courts – two factors that cannot be readily forecast – the likely scenarios for impacting the supply/demand balance for LCFS credits appear to be changes that are only likely to occur over a period of years. Potential impacts on LCFS credit prices will depend on how market participants balance their short-term needs with an ever-evolving perception of long-term market direction.

### Analysis

As a starting point, we will assume that LCFS credit trading occurs in a liquid market where key information is reasonably available to market participants. While those conditions may not be strictly true, they enable us to explain directional market behavior using fundamental principles of supply and demand. With that, prices observed in current market trading are based on the immediate needs of market participants and, more importantly because of banking, their expectations of how the supply and demand for credits can be expected to trend over the next several years. Accordingly, a decrease in credit prices can be anticipated when new developments cause market participants to either lower their expectations for the rate of deficit generation or increase their expectations for the rate of credit generation. With that in mind, we can categorize the types of developments which could lead to such changes in collective market expectations:

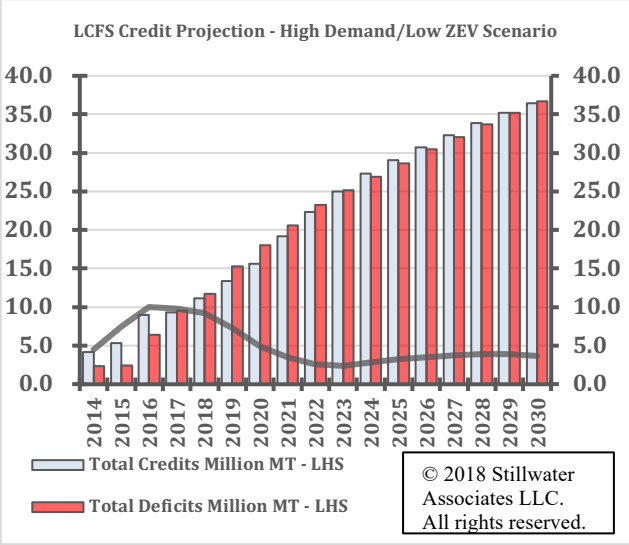
1. Potential causes for decreased deficit generation
    a. Lower than anticipated demand for fossil gasoline and diesel
    b. A relaxation of the LCFS CI reduction targets

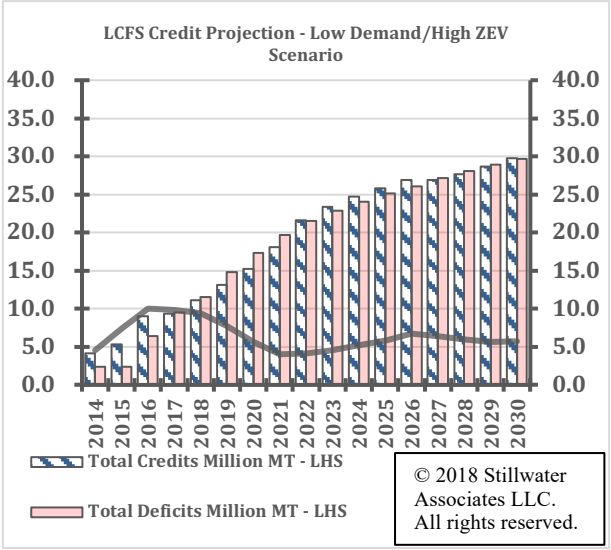
2. Potential causes for increased credit generation
    a. Increased availability of low-CI fuels
    b. Regulatory changes which allow higher percentages of low-CI blendstocks in gasoline and diesel (e.g., approval of E15)

**Lower than anticipated demand for fossil gasoline and diesel** – Gasoline and diesel are the primary deficit generators under the LCFS, thus lower demand for fossil gasoline and diesel can mean materially fewer deficits which require offsetting credits. This can occur due to a few different factors – slower growth in the overall vehicle population, a more rapid increase in fleet fuel economy, a decrease in Vehicle Miles Traveled (VMT), and faster growth in the population of natural gas and Zero Emission Vehicles (ZEVs). While forecasts for all of these are frequently updated, consequent changes in the rate

that deficit generation generally changes only slowly over the course of years. The exceptional cases would be a severe recession (which can cause VMT to drop quickly and only recover over a period of years) or a sustained increase in crude oil price sufficiently large and long-lasting to materially impact driver behavior.

In the rulemaking process for the 2018 LCFS amendments, CARB developed a pair of potential compliance scenarios labeled as "High Growth/Low ZEV Penetration" and "Low Growth/High ZEV Penetration" which can be compared to illustrate the potential market impact[1]. As there are multiple potential options for complying with the LCFS depending on such factors as overall transport fuel demand, price and availability of all different types of low-CI fuels and sales of natural gas and zero emission vehicles, these two scenarios should be seen as illustrative examples of how the market might respond to changes in any of these variables.



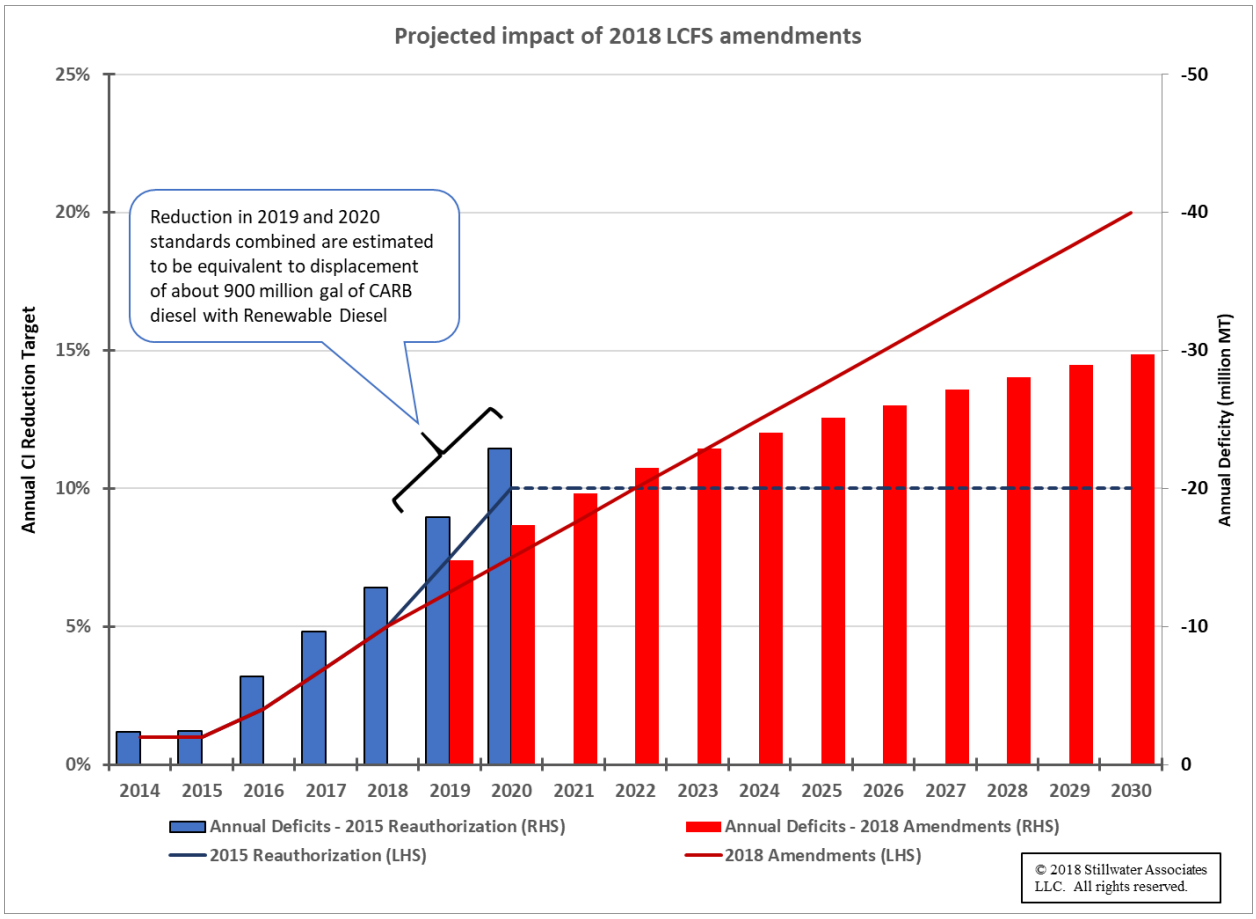

The difference between these two scenarios amount to a difference of 2.20 million MT of total credits banked at the end of 2023. This difference in credits is equivalent to displacing 231 million gallons of CARB diesel with 239 million gallons of Renewable Diesel (30 g/MJ CI), roughly the annual output of one large Renewable Diesel plant.

**A relaxation of the LCFS CI reduction targets** – Revisions to the LCFS which relax the CI reduction targets would lower the rate of deficit generation and, hence, the demand for LCFS credits. As CARB has recently approved a broad suite of program amendments which, in part, relax the near-term targets it is unlikely that another relaxation will occur in the near future on CARB's initiative[2]. CARB has, historically, revised the regulations to address program issues which arose in its operation, court rulings and market evolution; any future revisions which result in relaxation of the standards would only be expected if

[1] Details on these illustrative compliance scenarios in CARB spreadsheet model at https://www.arb.ca.gov/fuels/lcfs/2018-0815_illustrative_compliance_scenario_calc.xlsx
[2] Changes could be required at any time due to new legislation or in the event of another court order.

they project the market to fall substantially behind the existing schedule or if so directed by the courts or the legislature. Any such relaxation would occur through CARB's detailed rule-making process and provide stakeholders with plenty of notice of proposed changes and opportunity to be heard.

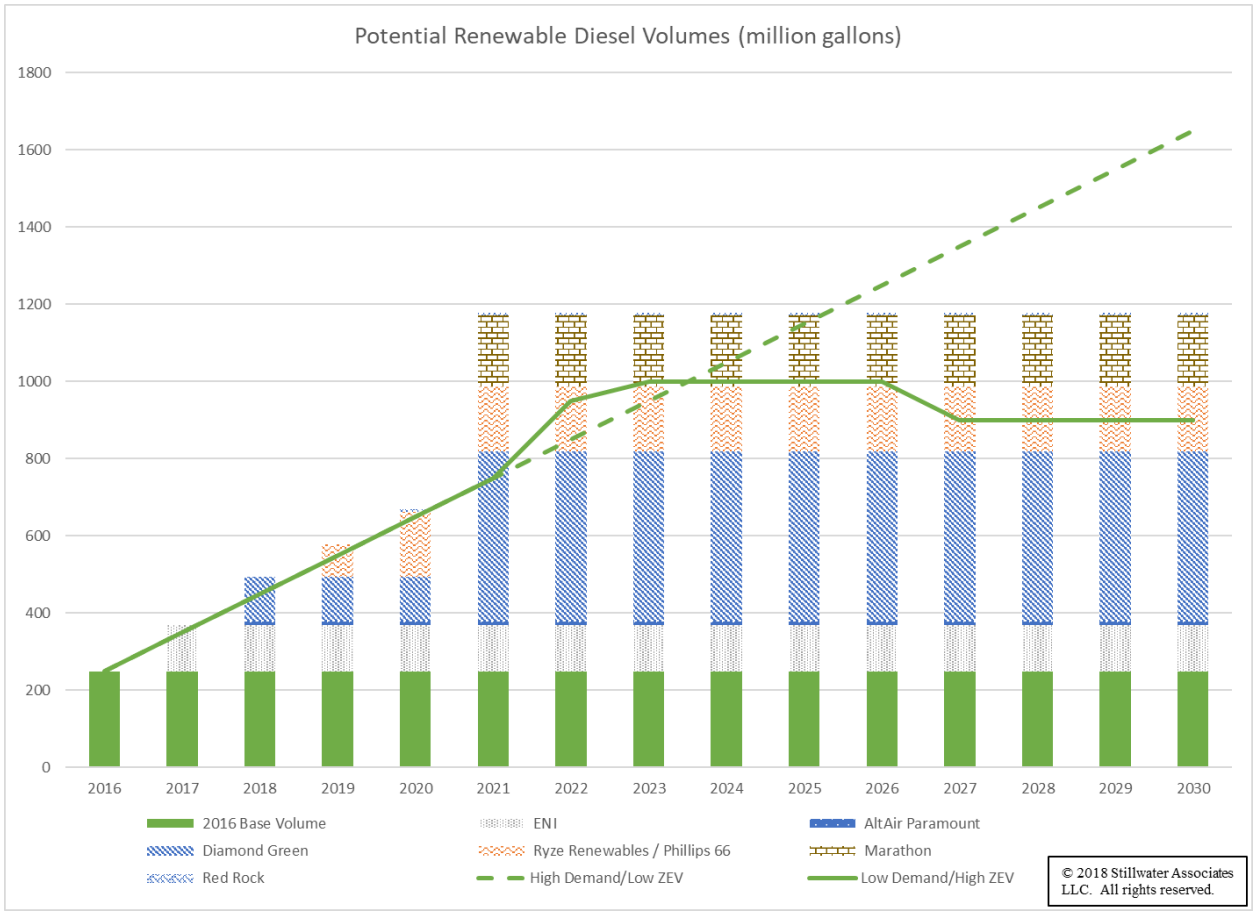
To quantify the potential impact of a hypothetical relation of the reduction targets, the following chart illustrated the magnitude of the change resulting from the relaxation of the 2019 and 2020 targets in the recently-adopted 2018 program amendments. While the 2018 amendments extend the program and ramp up the CI reduction target to 20% by 2030, it also relaxes the prior 2019 and 2020 targets from 7.5% and 10.0%, respectively, to 6.25% and 7.50%, respectively. This two-year relaxation effectively reduces deficit generation by an estimated 8 to 9 million MT in the two-year period, the equivalent of replacing about 900 million gallons of CARB Diesel with Renewable Diesel (CI of 30).




**Increased availability of low-CI fuels** – Meeting the annual increases in the LCFS CI reduction targets requires continuing increases in the supply of low-CI fuels or increased availability of natural gas vehicles and ZEVs. The capital projects required to produce this supply are costly and can take multiple years to develop. Further, they are the result of independent investment decisions taken by multiple companies. If, collectively, these individual assets come into production more slowly than required to enable California to

meet the standard, credits grow short and credit prices increase, potentially capped by the Credit Clearance Market (CCM) mechanism. Conversely, if projects come on more quickly than regulations require, LCFS credit availability may exceed market expectations and producers of these fuels may not be able to realize the product prices which they anticipated in making their investment decisions.

Stillwater tracks announcements of new low-CI fuel projects which may potentially supply product into California. Particular attention is paid to renewable diesel projects as they have been the incremental supply of LCFS credits in recent quarters. The lines on the chart below look at recent annual renewable diesel volumes earning LCFS credits and projects the future potential demands associated with the "High Demand/Low ZEV" and "Low Demand/High ZEV" scenarios described previously. The stacked bars on the chart represent the actual volume of renewable diesel earning LCFS credits in 2017 and the additional potential supply volumes associated with announced renewable diesel projects[3].




[3] The recently announced Phillips 66/REG joint venture project adjacent the Phillips 66 Ferndale, WA refinery is not included as the announcement did not include a projected capacity or start-up time. (https://investor.phillips66.com/financial-information/news-releases/news-release-details/2018/Phillips-66-and-Renewable-Energy-Group-Announce-Plans-for-Large-Scale-Renewable-Diesel-Facility-on-West-Coast/default.aspx)

This review suggests that the volumes associated with this year's expansions of Diamond Green and AltAir and the two announced Ryze Renewable/Phillips 66 projects (Reno and Las Vegas, NV) could easily be absorbed by California's demand. The additional volumes from the second expansion of Diamond Green announced for 2021 and the Marathon Dickinson, ND projects may face a more competitive market environment in their initial years. During this time, however, European demand for renewable diesel (commonly referred to as hydrotreated vegetable oil, HVO, in Europe) can also be expected to grow in response to their updated Renewable Energy Directive (RED II), potentially competing for some of the Neste production currently being imported into California.

This simple analysis does not consider many additional combinations of fuels which can be utilized to comply with LCFS requirements; the actual volumes demanded can be expected to vary with the relative costs of the different compliance pathways and growth in the California natural gas and ZEV fleets. A significant unknown is the use of Alternative Jet Fuel (AJF), allowed by the 2018 amendments as a compliance option for jet fuel supplied to aircraft in California. Projects potentially producing significant new volumes of AJF have been announced, but it remains unclear how much of that will be drawn into the LCFS market.

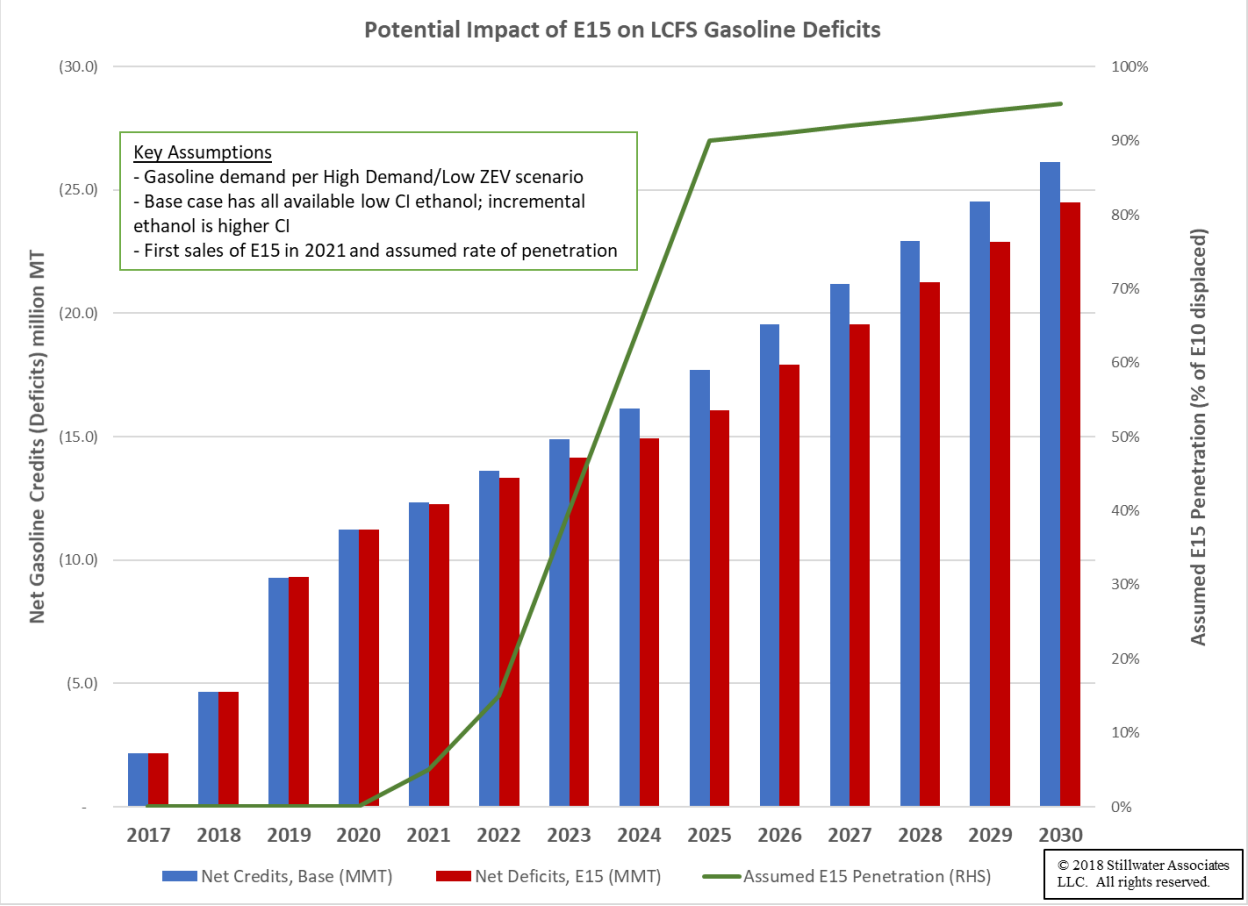
In summary, while announced projects suggest that considerable additions to the renewable diesel supply may become available to the California market over the next several years, this potential supply does not appear to be significantly out of balance with potential demand for LCFS credits.

**Regulatory changes which allow higher percentages of low-CI blendstocks in gasoline and diesel (e.g., approval of E15)** – To continually reduce the CI of gasoline and diesel fuel blends in California, producers need to either secure progressively lower CI biofuel blendstocks (ethanol, biodiesel and renewable diesel) or increase the blend percentage of these blendstocks in the finished fuels. As renewable diesel effectively has no upper blend limit, fuel suppliers have been able to progressively lower the CI of the California diesel pool by increasing the renewable diesel content, limited only by supply availability. On the gasoline side, however, virtually the entire pool is already blended at the 10% regulatory maximum, supplemented by limited volumes of E85. The rate of reduction in the CI of the state's gasoline pool, therefore, has been limited to the rate at which lower CI ethanol has become available to the market. One potential event which could significantly change this balance would be if the state were to permit the sale of E15[4]. Such approval would enable fuel suppliers to rapidly grow sales of E15, thus significantly reducing the number of non-renewable gasoline deficits and increasing the number of ethanol credits generated. While the formal approval would likely take some time to go through CARB's rule-making process, an announced intention by CARB to grant such approval may be expected to result in a significant drop in the market price of

[4] U.S. EPA has approved the use of E15 in FFVs and all 2001 and newer light-duty vehicles. Approximately 93% of 2019 model year vehicles sold in the U.S. have manufacturer's approval for the use of E15. EPA has explicitly not approved the use of E15 in heavy-duty gasoline engines, motorcycles and non-road engines.

LCFS credits. As it is expected that all available low-CI ethanol is already being used in blending E10, incremental ethanol is expected to be higher in CI.

The following chart illustrates the potential impact of E15 approval in California. It assumes the CARB High Demand/Low ZEV scenario described previously and assumes that E15 enters the California market in 2021, replacing 5% of E10 sales with an equivalent volume of E15[5]. This penetration is assumed to grow to 90% in 2025 (incentivized by LCFS credit values) and then level off. At 90% penetration, E15 reduces deficit generation by about 1.6 million MT per year; this is equivalent to replacing over 170 million gal per year of CARB Diesel with Renewable Diesel (30 CI). Accordingly, while market entry and actual penetration would only be expected to occur over several years, a perception that E15 is coming and will be broadly accepted by consumers could significantly impact the assessments of market participants.




[5] The actual volume of E15 exceeds that of the E10 displaced due to E15's lower energy content.

## In the News – October 2018

The first week of October was filled with summaries of the September 27th meeting that CARB held to vote on its extensive set of amendments to the LCFS. You can find our analysis of the final resolution (which was published in last week's newsletter) here.

On October 8th, CARB released a Tier 2 method 2B pathway for biodiesel produced from used cooking oil for a 10-day public comment period. The application comes from REG Danville, LLC in Illinois whose biodiesel product will be shipped by rail to California. More detailed information regarding the application can be found on CARB's website here: https://www.arb.ca.gov/fuels/lcfs/fuelpathways/comments/tier2/tier2_comments.htm

The Weekly Credit Transfer Report for October 1-7 was posted on CARB's website on October 9th.

- California Air Resources Board. Weekly LCFS Credit Transfer Reports. October 9, 2018. https://www.arb.ca.gov/fuels/lcfs/credit/lrtweeklycreditreports.htm

On October 9th, Waste360 released a piece on the first commercial-scale operation in California that will produce renewable natural gas for injection into the state's natural gas pipeline. The waste management company CR&R Environmental which is based in Stanton, California is converting organic waste to biogas which will then be further refined and distributed through SoCalGas' pipeline. The company has filed for a carbon negative 70-plus classification, which could lead to higher compensation under the LCFS

- Karidis, Arlene. Waste Company is First to Inject Biogas into California Pipeline. Waste 360. October 9, 2018. https://www.waste360.com/fuel/waste-company-first-inject-biogas-california-pipeline

On October 10th, the website AIN Online published an article looking at the recent buzz around sustainable alternative jet fuel (SAJF). Because of the strict safety considerations required of aircraft, environmentally-friendly fuel sources haven't been readily available until recently. The SAJF that has finally been deemed safe and viable for use is a "highly-concentrated product blended with standard petroleum-based jet fuel that adheres to ASTM D1655 and is ready to be placed into the wing of an aircraft." Once the fuel becomes more readily available, flight operators will play a big role in getting their "home base" to commit to using the product. In California, credits gained through the LCFS will help with this effort.

- AvFuel. Sustainable Alternative Jet Fuel: Operators Can Help Break the Wait. AIN Online. October 10, 2018. https://www.ainonline.com/sponsored-content/business-aviation/2018-10-09/sustainable-alternative-jet-fuel-operators-can-help-break-wait

The Weekly Credit Transfer Report for October 8-14 was posted on CARB's website on October 16th.

- California Air Resources Board. Weekly LCFS Credit Transfer Reports. October 16, 2018. https://www.arb.ca.gov/fuels/lcfs/credit/lrtweeklycreditreports.htm

On October 17th, Forbes published an article highlighting the positive outcome the LCFS has had on automakers, energy utilities, and oil companies in California. Since being enacted by Governor Arnold Schwarzenegger in 2007, the program's first decade was filled with obstacles. Lawsuits, heavy lobbying for its elimination, and criticism from politicians it desperately needed on its side were just a few of the hurdles the program faced. A decade later, the LCFS has not only endured but thrived with the average carbon intensity of fuels sold in California declining almost 5% since 2010, which has resulted in a reduction of over 38 million tons of carbon.

- Sperling, Daniel. How (Almost) Everyone Came to Love Low Carbon Fuels In California. Forbes. October 17, 2018. https://www.forbes.com/sites/danielsperling/2018/10/17/how-almost-everyone-came-to-love-low-carbon-fuels-in-california/

On October 22nd, Capitol Weekly released an opinion piece regarding the recent set of clean transportation rules CARB approved last month paying particular attention to the amendments to the LCFS. According to the article, California's clean transportation policies (including the LCFS) could save households up to $1,500 annually by 2030, and "going forward, the standard sends a market signal that we are on a clear path to clean, low-carbon fuels. This is a green light for investment in our state, as businesses now understand that Californians want more and better fuel choices, beyond conventional gasoline and diesel."

- Baker-Branstetter, Shannon. Tougher rules to curb vehicle pollution. Capitol Weekly. October 22, 2018. http://capitolweekly.net/tougher-rules-curb-vehicle-pollution/

The Weekly Credit Transfer Report for October 8-14 was posted on CARB's website on October 16th.

- California Air Resources Board. Weekly LCFS Credit Transfer Reports. October 16, 2018. https://www.arb.ca.gov/fuels/lcfs/credit/lrtweeklycreditreports.htm

On October 25th, Biodiesel Magazine published an article highlighting the effect California's LCFS has had on the policy objectives of other states and countries. From a policy-design standpoint the program is appealing because it does not require an annual appropriation and allows GHG modeling to change over time. Oregon, British Columbia, and Brazil in particular are paying close attention to the LCFS and have developed their own versions. According to the article, the Low Carbon Fuels Coalition is "working with BIO and the World Business Council for Sustainable Development's below50 program to further expand comparable policies. below50 is active in Australia, Brazil, Europe and the U.S., and it is seeking to promote LCFS-type policies at both the federal and the state or provincial level."

- Noyes, Graham. Driving Decarbonization. Biodiesel Magazine. October 25, 2018. http://www.biodieselmagazine.com/articles/2516487/driving-decarbonization

On October 29th, Biofuels Digest published an article about the $350 million investment World Energy will make over the next two years to complete the conversion of its Paramount, California facility into "one of the cleanest refineries in the world." The article credits the LCFS with being both catalyst and inspiration for the project, and according to Anthony Rendon of World Energy, "The environmental state policies we have written are

working and have paved the way for these significant investments in our communities allowing World Energy to demonstrate the economic potential of renewable fuels for California."

- Lane, Jim. Take-Off: 350 million bucks towards drop-in aviation biofuels for the California market. Biofuels Digest. October 29, 2018. http://www.biofuelsdigest.com/bdigest/2018/10/29/take-off-350-million-bucks-towards-advanced-drop-in-alternative-aviation-fuels-for-the-california/

On October 25th, CARB released two Tier 2 Method 2B Pathways for solar-based (Photovoltaic) electricity electric vehicle charging stations for a 15-day public comment period. Both pathways come from Powerflex, located in California. More information and submitted comments can be found on CARB's website: https://www.arb.ca.gov/fuels/lcfs/fuelpathways/comments/tier2/tier2_comments.htm

The Weekly Credit Transfer Report for October 22nd-28th was posted on CARB's website on October 30th.

- California Air Resources Board. Weekly LCFS Credit Transfer Reports. October 30, 2018. https://www.arb.ca.gov/fuels/lcfs/credit/lrtweeklycreditreports.htm

On October 31st, Western Livestock Journal published an article regarding the considerable growth methane digesters that produce renewable natural gas (RNG) are seeing in livestock operations recently. The article credits California's incentives, such as the $69.9 million the California Department of Food and Agriculture recently awarded that will fund 40 dairy digesters across the state, as well as the renewable energy credits and LCFS credits up for grabs if the operation can find a pathway to sell and deliver the natural gas to vehicles in California.

- Clayton, Chris. Renewable fuel credits sparking growth in livestock digesters. Western Livestock Journal. October 31, 2018. https://www.wlj.net/top_headlines/renewable-fuel-credits-sparking-growth-in-livestock-digesters/article_fdf3aa30-dd25-11e8-9b88-bf8534fc778d.html

The Weekly Credit Transfer Report for October 29th – November 4th was posted on CARB's website on November 6th.

- California Air Resources Board. Weekly LCFS Credit Transfer Reports. November 6, 2018. https://www.arb.ca.gov/fuels/lcfs/credit/lrtweeklycreditreports.htm

**In Canadian Carbon Policy News:**

On October 16th, Ethanol Producer Magazine published a blog post about the progress of the ambitious plan Canada's liberal party published in 2015 to "reduce emissions, put a price on carbon, deliver green jobs and spur innovation in a thriving clean-tech industry." Three years later, the Trudeau administration is reaching some of the goals, but the transition to low-carbon fuels has been challenging. According to the author, "the government has relied on extensive consultations and stakeholder engagement as part of its policy design process. Renewable Industries Canada thinks productive consultations are essential for policies like the [Clean Fuel Standard] to execute and deliver. And everyone at the proverbial table has to come forward with solutions."

- Kent, Andrea. How Lessons from Business Can Help Canada's Climate Agenda. Ethanol Producer Magazine. October 16, 2018. http://ethanolproducer.com/articles/15660/how-lessons-from-business-can-help-canadaundefineds-climate-agenda

On October 23rd, Bloomberg spotlighted Canadian Prime Minister Justin Trudeau's announcement that the federal government will impose a carbon tax on the four Canadian provinces who have failed to implement their own carbon-reduction policies. The plan, which taxes both industrial emitters and fuels, will be rolled out on January 1, 2019. Trudeau told CBC Radio that "a number of the provinces have refused to do that, so because pollution doesn't stop at provincial borders, we're going to move forward with a federal approach. People will be better off, families will be better off because of the carbon incentive we're returning to them." Much of the revenue collected through the carbon tax will be returned to individuals as tax rebates.

- Wingrove, Josh. And Greg Quinn. Trudeau Imposes Carbon Tax, With Rebates, on Four Provinces. Bloomberg. October 23, 2018. https://www.bloomberg.com/news/articles/2018-10-23/trudeau-said-to-announce-carbon-plan-tuesday-for-holdout-ontario